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Stennis Space Center, MS 39529-5004

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Software Requirements Specification for the Globally Relocatable Navy Tide/Atmosphere Modeling System (PCTides)

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13. ABSTRACT (*Maximum 200 words*)

The purpose of this Software Requirements Specification (SRS) is to specify the functional requirements for the Globally Relocatable Navy Tide/Atmosphere Modeling System (PCTides). It describes the input to the system, processing flow, output of the system, and the objective analysis. PCTides is part of the Oceanographic and Atmospheric Master Library (OAML) and is actively configuration managed under the direction of that authority. This document, along with the Software Design Description (Hubbert et al., 2001) and the Software Test Description (Preller et al., 2001) form the standard documentation package for the OAML PCTides.

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1.0 SCOPE

1.1 IDENTIFICATION

The Software Requirements Specification (SRS) establishes the requirements for the Computer Software Configuration Item (CSCI) identified as the Globally Relocatable Navy Tide/Atmosphere Modeling System (PCTides).

1.2 System Overview

The Computer Software Configuration Item (CSCI), identified as the Globally Relocatable Navy Tide/Atmosphere Modeling System (PCTides) consists of a 2- and 3-dimensional barotropic tide/surge model, called the Global Environmental Modeling Services (GEMS) Coastal Ocean Model (GCOM2D and GCOM3D), and a Mesoscale Atmospheric Prediction System (MAPS).

GCOM2D is a depth-integrated shallow water model designed to characterize sea level and currents on or near continental shelves. It features a wetting and draining algorithm for simulating coastal flooding due to tides or storm surge.

GCOM3D is the three-dimensional counterpart to GCOM2D. It is a barotropic model for applications where current structure with vertical depth is required and tidal and wind forcing are dominant. Atmospheric forcing for GCOM2D/3D is provided by an existing operational Navy model, by the MAPS system, by an analytical hurricane vortex model, or by direct point observation.

MAPS is a hydrostatic primitive equations model designed to provide high-resolution representations of anemometer level winds and surface pressure as atmospheric boundary conditions for GCOM2D and GCOM3D. To this end, the turbulence closure scheme has been designed to allow the model to be run with its lowest model level at anemometer height, thus providing a direct simulation of the winds at this level. The equations of motion are coded in advective form and solved using a semi-implicit time differencing scheme ensuring that the model is both robust and economical to run, even in regions of steep terrain.

1.3 Document Overview

The purpose of this document is to specify the functional requirements for the tide/surge portion of PCTides, GCOM2D/3D. It describes the input to the system, processing flow, output of the system, and the objective analysis. This document has been written to the software documentation standards for environmental system product development. Each facet of the model, including I/O and algorithms, are described in general terms, avoiding explanations of the coding used to implement these quantities. Coding is explained in detail in the PCTides Software Design Description. This document is divided into the following sections:

Manuscript approved February 23, 2001.

Section 1	Identifies the CSCI system, providing an overview of the system requirements within this document.
Section 2	Provides a list of all documents referenced within the program.
Section 3	Specifies the CSCI requirements that are conditions for acceptance by the system.
Section 4	States the methods used to ensure that each requirement has been met.
Section 5	Provides the ability to trace each CSCI requirement in this specification to the system requirements it addresses.
Section 6	Provides applicable notes including a glossary of acronyms.
Appendix A	Provides a Software Requirements Specification for the MAPS atmospheric model.

2.0 REFERENCED DOCUMENTS

2.1 Software Documentation Guidelines

Oceanographic and Atmospheric Master Library Summary. Naval Oceanographic Office, System Integration Department. OAML-SUM-21F. April, 1998.

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2.2 General Technical Documentation

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3.0 REQUIREMENTS

This section discusses the PCTides capabilities, interface, adaptation, and resource requirements. PCTides has been written to be user friendly and platform independent by which the model can be executed through a graphical user interface or a DOS mode or UNIX command line prompt. All PCTides configuration managed routines and subroutines are written in FORTRAN 90.

3.1 CSCI Capability Requirements

The GCOM2D portion of the PCTides model is a hydrodynamic model used to model depth-integrated currents and sea surface height on or near continental shelves and can be adapted to simulate coastal flooding due to tides and storm surge. GCOM3D is a barotropic *z*-coordinate model used to characterize current structure with vertical depth when tidal and wind forcing dominate. The MAPS portion of the model contributes an atmospheric forcing element to the model. It provides high resolution spatial representation of the wind and pressure fields for GCOM2D/3D.

There are five main capabilities in the GCOM2D/3D model that will perform the following functions:

Set up grid, bathymetry and boundary conditions.

Derive surface winds and atmospheric pressures (if desired).

Set parameters for controlling the type of forcing and model output.

Select and run GCOM2D or 3D model using the same setup data.

Select output display options.

Within each of these capabilities are several subfunctions that serve to input information into the model and to produce a variety of output files for the specified analysis region which are described in the following subsections. For each subfunction, a description of inputs and outputs are provided for both PC Windows menu and command prompt use. Figure 3.1-1 illustrates the interactions between the functions and subfunctions within the PC Windows interactive menu.

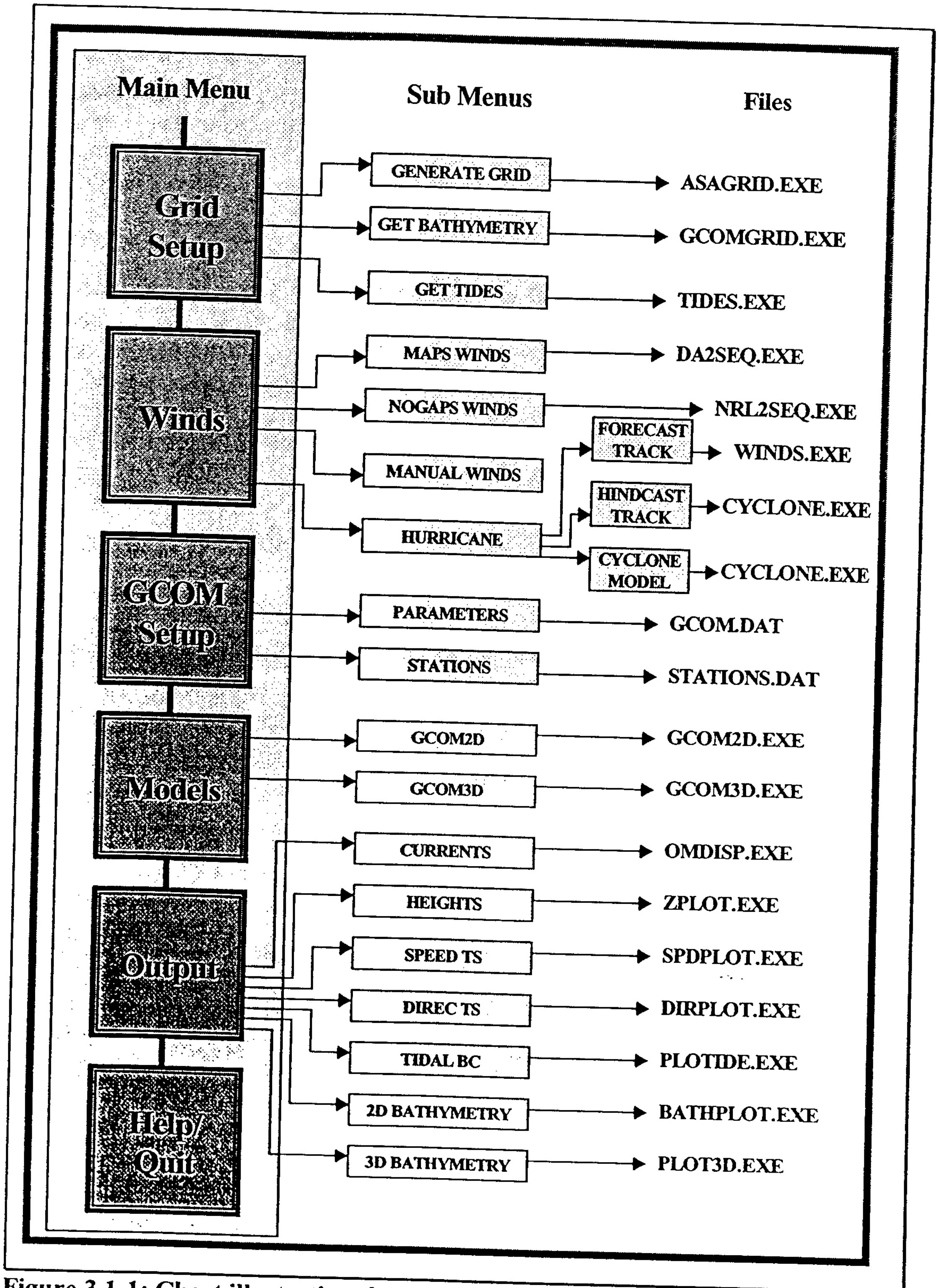

Figure 3.1-1: Chart illustrating the PC Windows Menu and related files.

3.1.1 Set Up Grid, Bathymetry and Boundary Conditions

3.1.1.1 Define the model domain

Command Prompt

Input:

Input values for parameters such as area title, grid projection flag, latitude and longitude limits, and standard grid spacing to create "gridgen.dat" in the "\gems\work" directory. It is structured as follows:

Line	Parameter	Typical value
1	Arbitrary Title	Persian Gulf
2	Grid Projection Flag **(do not change)**	3
3	Southern Latitude Limit	22.0000
4	Northern Latitude Limit	31.0000
5	Western Longitude Limit	46.0000
6	Eastern Longitude Limit	60.0000
7	Standard Grid Spacing (kms)	10.0

Output:
File "gridgen.dat".

Menu

Input:
The "Generate Grid" menu option initiates the ASA grid projection program. A unique output file name must be specified for identification and storage.

Output:
An ASCII file is written to the "\gems\gridgen\depths" directory with the user specified file name and an ".asc" extension. This file contains the latitude and longitude limits of the region selected.

3.1.1.2 Generate the bathymetry on defined grid

Bathymetry and topography are extracted for each grid point for the selected model region. The latitude and longitude of the grid point are determined and all direct access topography files are searched to find the value at that location from the highest resolution ".da" file containing that point.

Command Prompt

Input:
The program "gridgen" that reads the latitude and longitude limits resolution stored in the "gridgen.dat" file generates the bathymetric grid from the global direct access files.

Output:
"Gridgen" writes the data to the file "topog.dat" in the "\gems\work" directory.

Menu

Input:
"Get Bathymetry", found in the menu toolbar, runs the program "gemsgrid". "Gemsgrid" reads the latitude and longitude limits stored in the ".asc" file and generates the bathymetric grid from global direct access files.

Output:
Writes bathymetric data to the file "topog.dat" in the \gems\work" directory.

3.1.1.3 Get tidal boundary conditions

Tidal boundary conditions are derived for the model region from the global tidal files for eight constituents by determining the grid from the topography file and then writing the following files:

m2.dat
s2.dat
n2.dat
k2.dat
2n2.dat
o1.dat
k1.dat
q1.dat

Command Prompt:

Input:
Run "tides".

Output:
Creates gridded file of tidal boundary conditions.

Menu:

Input:
"Get Tides" is selected for deriving tidal boundary conditions.

Output:
Creates gridded file of tidal boundary conditions.

3.1.2 Derive Surface Winds and Atmospheric Pressure (if desired)

Before the model is run, the winds to force the ocean model may be obtained from three possible sources: 1) NOGAPS or some available higher resolution winds (COAMPS/DAMPS), 2) entered manually, or 3) developed using the hurricane model.

For more information refer to Appendix A.

3.1.2.1. Derive NOGAPS or some higher resolution winds

NOGAPS or some higher resolution wind (i.e., COAMPS/DAMPS) files are used to derive surface winds and atmospheric pressures to force the ocean model.

Command Prompt

Input:
MAPS winds may be derived by running "da2seq". NOGAPS or some higher resolution winds may be derived by running "nrl2seq".

Output:
The atmospheric file, which contains surface winds and pressure, is interpolated to the model grid using "topog.dat" and written to the binary sequential file "atmos.dat".

Menu

Input:
Model winds may be derived by selecting "MAPS Winds" or "NOGAPS Winds" from the menu.

Output:
The atmospheric file, which contains surface winds and pressure, is interpolated to the model grid using "topog.dat" and written to the binary sequential file "atmos.dat".

3.1.2.2 Enter winds manually

Winds may also be entered manually. This option is useful if the model is running over a small area where the user believes the local wind station observations and/or forecasts may be more accurate (or available) than model output winds. It is less accurate for larger model regions as there is no accounting for spatial variation of the winds.

Command prompt

Input:
"Winds.dat" must be edited by specifying the start date, hour, and the local time zone and then input wind speeds (in knots) and directions (the direction in degrees, clockwise from true north, from which the wind is coming) at specified time intervals from the start time. Once "winds.dat" has been edited, run "winds".

Output:
Upon completion data are placed on the model grid using the "topog.dat" file and are written to the "atmos.dat" file. This produces a wind file that is time varying but spatially constant.

Menu

Input:
Select "Manual Winds" from the toolbar. Enter the required data in the "manual winds" panel of the menu.

Output:
Upon completion data are placed on the model grid using the "topog.dat" file and are written to the "atmos.dat" file. This produces a wind file that is time varying but spatially constant.

3.1.2.3 Derive hurricane winds

A hurricane model (the terms "hurricane" and "cyclone" are synonymous in this documentation) is used which takes in track parameters and develops wind and atmospheric pressure fields. Options for entering forecast track data for real-time usage or the simulation of historical events (hindcasts) are provided.

3.1.2.4 Forecast track

The forecast track is defined in the "cyclone.dat" file. The menu offers a more interactive method of establishing the track than can be accomplished at the command prompt; therefore they are described separately. The structure of this file is as follows (with sample values included):

Line	Parameter	Typical Value
1	Environmental pressure (hPa)	1005
2	Holland "b" parameter (see SDD 5.2.4.3)	1.75
3	Dummy integer parameter	0
4	Output time step (hours)	0.5
5	Dummy real parameter	0.0
6	Plot flags (wind, MSLP,dummy)	0 0 0
7	Time zone	8.0
8	Date, Time, Latitude, Longitude, Pressure, Radius of Maximum Winds	19990322 0400 -20.80 114.50 915.0 33.0
9	repeat line 8 for each time step	

Command prompt

Input:
The "cyclone.dat" file is edited to set up the track data.

Output:
Updated track information is stored in "cyclone.dat".

Menu

Input:
The track is defined by entering the required parameters concerning the initial state of the hurricane (latitude, longitude, central pressure, speed, radius of maximum winds, date and time) and then specifying its expected coastal crossing point or destination.

Output:
Updated track information is stored in "cyclone.dat".

3.1.2.5 Hindcast Track

Historical tracks can be hindcast from stored track files by recovering the historical track file from "\gems\tctracks" where it is stored with a ".trk" extension. Copying the format of existing files and allocating an appropriate name (less than 9 characters) can create new historical track files.

Command prompt

Input:
Copy required track file from "\gems\tctracks" to "cyclone.dat" in the "\gems\work" directory. Edit the "cyclone.dat" file to adjust the start time if required.

Output:
Updated track information is stored in "cyclone.dat".

Menu

Input:
Enter the name of the required hurricane track file. Adjust the start time if simulation of the entire hurricane track is not necessary (for example, if the hurricane is still far away from the coast at the beginning of the track).

Output:
Updated track information is stored in "cyclone.dat".

3.1.2.6 Hurricane Model

After a forecast or hindcast track file is established, the hurricane model generates wind and pressure fields on the model grid by referring to the "topog.dat" file.

Command prompt

Input:
Run "cyclone".

Output:
Upon completion, surface wind and pressure fields are interpolated on the model grid using "topog.dat" file and written to "atmos.dat".

Menu

Input:
Select "CYCLONE Model".

Output:
Upon completion, surface wind and pressure fields are interpolated on the model grid using "topog.dat" file and written to "atmos.dat".

3.1.3 Set Parameters for Controlling the Type of Forcing and Model Output

3.1.3.1 Set GCOM parameters

Prior to running the ocean model, parameters that control the type of forcing and model output must be established.

Input:
There are a few parameters that must be specified for the model run. These are stored in the file "gcom.dat" which has the following structure (sample values at end of line):

Note: Refer to the User's Manual for instructions on editing these parameters.

Line	Parameter	Typical Value
1	wind flag (0=off, 1=on)	1
2	tide flag (0=off, 1=on, 2=on + tidal data assimilation)	1
3	nesting flag (0=off, 1=on)	0
4	screen flag (0=text, 1=vectors)	0
5	inundation flag (0=off, 1=on)	0
6	wave setup or datum adjustment (meters)	0.0
7	output file time interval (hours, 0=none)	1.0
8	tidal start time, time zone (hh,mm,dd,mm,yyyy,hours)	00 00 23 06 1999 19.0
9	maximum model run time (hours)	168

<u>**Command prompt**</u>

Input:
Edit "gcom.dat".

Output:
Updated "gcom.dat" file.

<u>**Menu**</u>

Input:
Select "Parameters".
Set parameters in the input panel.

Output:
Updated "gcom.dat" file.

3.1.3.2 Define stations

One of the features of the model is to produce time series output of sea levels and ocean currents at specified locations. Prior to running the model, the location of these "stations" must be defined by setting up the "stations.dat" file.

The "stations.dat" file may have up to 30 stations (one per line) defined as latitude, longitude and name. The user is advised to have at least one output station defined for each model run. The format for the "stations.dat" file is as follows:

Latitude (-90.0 to 90.0)	Longitude (0 to 360 E)	Station Name (max 8 characters)	Model Output Level (1 for GCOM2D)
26.17000	56.55000	Pgulf1	1
26.70000	56.28000	Pgulf2	1
24.00000	58.00000	Pgulf3	1
26.50000	53.40000	Pgulf4	1
25.67000	52.40000	Pgulf5	1
24.45000	53.37000	Pgulf6	1
27.00000	49.72000	Pgulf7	1
29.27000	50.33000	Pgulf8	1
29.83000	48.72000	Pgulf9	1

The set of stations defined for a model region can be saved with a ".stn" extension in the "work" directory and recalled for later model runs.

<u>Command prompt</u>

Input:
Copy a ".stn" file to "stations.dat" and/or edit "stations.dat".

Output:
Updated station information is stored in "stations.dat".

<u>Menu</u>

Input:
Select "Stations".
Select a stored stations file.
Edit the station data and save (exit).

Output:
Updated station information is stored in "stations.dat".

3.1.4 Run GCOM2D Or 3D Model

Either GCOM2D or GCOM3D may be run using the same set up data. The user would normally only use GCOM3D if near-surface currents were required. GCOM2D is faster and is used to predict sea levels as a result of tidal and/or hurricane forcing. GCOM2D can also simulate the inundation of coastal regions as a function of tidal ebb and flood or storm surge.

<u>**Command prompt**</u>

Input:
Run "gcom2d" or "gcom3d".

Output:
Once the model run begins, numerical data will appear on the screen. This data list displays the stations entered into the station file and the depths at that location associated with the model topography, the model time step and tidal time series time step, as well as the number of observational stations in the domain.

<u>**Menu**</u>

Input:
Select "GCOM2D" or "GCOM3D".

Output:
Once the model run begins, numerical data will appear on the screen. This data list displays the stations entered into the station file and the depths at that location associated with the model topography, the model time step and tidal time series time step, as well as the number of observational stations in the domain.

3.1.5 Select an Output Display Option

Various forms of display options are available for the PC user that may be run under the PC Windows Menu or at the DOS mode command prompt. The display code has been written for the PC format so there are no display options for running under UNIX.

3.1.5.1 Ocean currents and sea levels

Both GCOM2D and GCOM3D write output fields to the sequential binary file "gcom.out" at each model output time step. Currents and sea levels from this file may be displayed by running "omdisp" which offers an interactive menu to set display options.

<u>**Command prompt**</u>

Input:
Run "omdisp" to set display options in the menu panel.

Output:
Plot of the horizontal fields of currents and sea levels.

<u>**Menu**</u>

Input:
Select "Currents" to set display options in the menu panel.

Output:
Plot of the horizontal fields of currents and sea levels.

3.1.5.2. Tidal height time series

When the user specifies stations in the menu or edits the "stations.dat" file, the model produces time series output at those stations and writes to a file with the station name and an extension of ".tsd".

<u>**Command prompt**</u>

Input:
Run "zplot" to specify the input file.

Output:
Time series plot of model tidal height at a specified station. If data assimilation has been chosen for the model then tidal predictions for each station are written to a file with the station name and the extension ".thp". The ".thp" file types may also be plotted or overlayed on the station plots.

<u>**Menu**</u>

Input:
Select "Height TS" to specify the input file.

Output:
Time series plot of model tidal height at a specified station. If data assimilation has been chosen for the model then tidal predictions for each station are written to a file with the station name and the extension ".thp". The ".thp" file types may also be plotted or overlayed on the station plots.

3.1.5.3 Current speed and direction time series

As described earlier the time series of current speeds and directions are written to ".tsd" files and may then be plotted.

<u>**Command prompt**</u>

Input:
Run "spdplot" or "dirplot" and specify the input station.

Output:
Time series plot of current speeds and directions.

Menu

Input:
Select "Speed TS" or "Direc TS" and specify the input station.

Output:
Time series plot of current speeds and directions.

3.1.5.4 Tidal amplitudes and phases from the FES95.1/2.1 model

Command prompt

Input:
Run "plotide" and specify the tidal constituent file ("m2.dat", "o1.dat" etc. as defined in section 3.1.1.3) and chose to include (or not) International Hydrographic Office (IHO) tidal station data in the output.

Output:
Plots of tidal amplitude and phase from the global tide model and, if chosen, IHO station amplitude and phase.

Menu

Input:
Select "Tidal BC" and specify the tidal constituent file (m2.dat, o1.dat etc. as defined in section 3.1.1.3) and chose to include (or not) IHO tidal station data in the output..

Output:
Plots of tidal amplitude and phase from the global tide model and, if chosen, IHO station amplitude and phase.

3.1.5.5 Three-Dimensional Bathymetry

The program "plot3d" creates a three-dimensional surface mesh plot of the model bathymetry and topography. This program reads the "topog.dat" file and offers choices of viewing rotation angle (0-360° from due south) and viewing elevation angle (0-90°).

Command prompt

Input:
Run "plot3d".

Output:
3-D surface mesh plot of PCTides bathymetry and topography.

Menu

Input:
Select "3D Bathymetry".

Output:
3-D surface mesh plot of PCTides bathymetry and topography.

3.1.5.6 Two-Dimensional Bathymetry

The program "bathplot" generates a two-dimensional contour plot of the model bathymetry and color-coded topography. This program reads the "topog.dat" file and allows the user to set the minimum plotting contour (in meters). The color coding of the topography is defined on the bottom of the plot. This program may be run in the following manner.

Command prompt

Input:
Run "bathplot".

Output:
2-D contour plot of the model bathymetry and color-coded topography.

Menu

Input:
Select "2D Bathymetry".

Output:
2-D contour plot of the model bathymetry and color-coded topography.

3.2 CSCI External Interfaces

3.2.1 Interface Identification and Diagrams

The only Navy standard PCTides external interfaces are the input and output files.

The **input** files consist of the following types of data:

1. archived topographic data.
2. model domain parameters in 'GRIDGEN.DAT'.
3. Global Tide Model (FES95.1/2.1) data.
4. wind data from NOGAPS or some higher resolution field (i.e., COAMPS/DAMPS), from manual data entry, or derived from the hurricane model.
5. various parameter and station location data for GCOM2D/3D.

The **output** files consist of the following types of data:

1. output stations where time series predictions of sea levels and currents are stored.
   output consisting of sea level and current spatial fields for the entire grid at preset (parameter file) time steps.

The interfacing and operational environment for PCTides, which demonstrates the relationship between the components of the system and associated files, is illustrated in Figure 3.2-1.

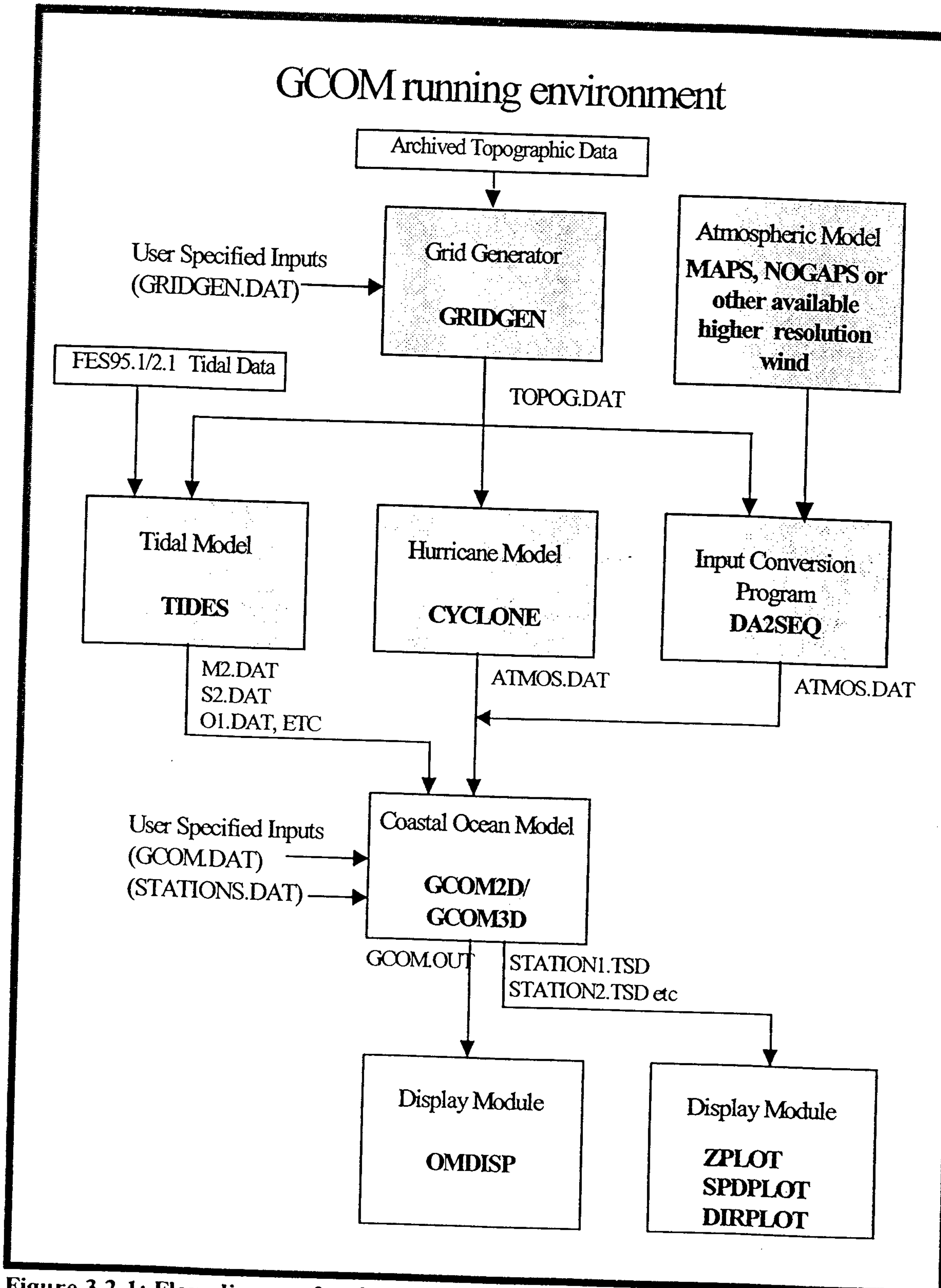

Figure 3.2-1: Flow diagram for the GCOM system.

3.3 CSCI Internal Interface Requirements

The CSCI will be run from either a PC Windows interactive menu or through a DOS mode or UNIX command prompt. Refer to Figure 3.1-1 for an illustration of the internal interfacing of PCTides.

3.4 CSCI Internal Data Requirements

In PCTides the MAPS and GCOM running environments contain several other modules and programs that are necessary to complete the modeling system. These include programs for setting up model grids over specified geographic regions, extraction and conversion programs in a suitable format for MAPS and GCOM2D and display options for viewing model output (SDD; Hubbert et al., 2000).

MAPS Internal Programs:

1. Grid Generator-GRIDGEN
2. Input Conversion Program-NOGAPS
3. Field Generator-AMSUBGRD
4. Preprocessor-AMPREPSL, AMPREPPL
5. Display Modules-AMDISP, TSPLOT

GCOM Internal Programs:

1. Grid Generator-GRIDGEN
2. Input Conversion Program-DA2SEQ
3. Atmospheric Model-MAPS
4. Tidal Model-TIDES
5. Hurricane Model-CYCLONE
6. Display Module-OMDISP, TSPLOT

3.5 Adaptation Requirements

There are no special adaptation requirements.

3.6 Security and Privacy Requirements

There are no CSCI security or privacy requirements.

3.7 CSCI Environment Requirements

The PCTides model can be operated on PC Windows/DOS or UNIX operating systems. The program also could be easily ported to other UNIX-type operating systems such as LINUX by developers familiar with those environments.

3.8 Computer Resource Requirements

The CSCI planned use of computer hardware resources is about 360 MB for both PC Windows/DOS and UNIX systems.

3.9 Software Quality Factors

PCTides has been proven to perform all required functions and has been thoroughly tested, as evidenced in Section 4.0, Qualifications Provisions and the Software Test Description. Due to the modularity of the program, problems can be easily corrected, and the program can be adapted to changing requirements or modified for use in a new environment. The CSCI is user-friendly and can be utilized in a variety of applications.

3.10 Design and Implementation Constraints

None.

3.11 Training and Personnel-Related Requirements

Personnel must trained in the use of either UNIX or the PC Windows operating systems to properly enter data and evaluate the model results to assure high quality output from PCTides. The interactive menu offered in the PC Windows format of this program greatly simplifies manipulation of the CSCI input and output options.

3.12 Other Requirements

None.

3.13 Precedence and Criticality of Requirements

None.

4.0 QUALIFICATION PROVISIONS

The table below lists the validation test matrix for the CSCI requirements outlined in this specification.

Section/Module Identification	Validation type/ Reference	Analysis Area	No. of tests
3.1.1	Haltiner and Williams, 1980		
3.1.4, 3.1.6 MAPS	Holland, G.J., (1980)	Australia-Darwin, Port Hedland;	3 tests
3.1.7-3.1.10	Hubbert, G.D. et al. (1991)	Cowley Beach, Australia	6 tests
3.1.7-3.1.10 GCOM2D/3D	Hubbert, G.D. and McInnes, K.L., (1999a)	Australia-Port Hedland, Port Phillip	2 tests
3.1.7-3.1.10	Hubbert, G.D. et al., (1990)	Australia- Bass Strait	1 test
MAPS; GCOM3D	Mellor, G.L. and Yamada, T. (1974, 1982)		
GCOM2D	Miller, M.J., and Pearce, R.P., (1974)		
MAPS	Smith, S.D., and Banke, E.G. (1975)	Sable Island, Nova Scotia;	1 test
GCOM2D	Shapiro, R., (1970)		
GCOM2D/3D	Signell, R.P. and Butman, B. (1992)	Boston Harbor, Mass.	1 test
3.1-3.13	STD; Preller et al. (2000)		8 tests

5.0 REQUIREMENTS TRACEABILITY

The Software Test Description (STD) includes eight test runs that encompass all CSCI routines (SDD) and requirements (SRS).

SRS paragraph numbers:

SDD Paragraph numbers:	3.1.1	3.1.2	3.1.3	3.1.4	3.1.5	3.1.1A	3.1.2A	3.1.3A	3.1.4A
5.1		x	x					x	
5.1.2								x	
5.1.3								x	
5.1.4						x	x	x	x
5.2				x					
5.2.2				x					
5.2.3			x	x					
5.2.4	x	x		x	x				x
5.3				x					
5.3.2				x					
5.3.3				x					
5.4	x					x			
5.5	x								
5.6	x								
5.7	x								
5.8								x	
5.9				x					
5.10.1	x					x			
5.10.2		x					x		
5.10.3	x								

6.0 NOTES

6.1 Acronyms

ASA	Applied Sciences Associates
CSCI	Computer Software Configuration Item
CSC	Computer Software Component
FES	Finite Element Solutions
GCOM2D	Coastal Ocean Model 2-D
GCOM3D	Coastal Ocean Model 3-D
GEMS	Global Environmental Modeling Systems
GMT	Generic Mapping Tool
IHO	International Hydrographic Office
MAPS	Mesoscale Atmospheric Prediction System
NOGAPS	Navy Operational Global Atmospheric Prediction System
NRL	Naval Research Laboratory
OAML	Oceanographic and Atmospheric Master Library
PC	Personal Computer
PSI	Planning Systems, Incorporated
SDD	Software Design Description
SRS	Software Requirements Specification
SSC	Stennis Space Center
STD	Software Test Description
UNIX	Workstation Operating System

APPENDIX A

SOFTWARE REQUIREMENTS SPECIFICATION

FOR THE

GLOBALLY RELOCATABLE NAVY TIDE/ATMOSPHERE MODELING SYSTEM (PCTides)

MESOSCALE ATMOSPHERIC PREDICTION SYSTEM (MAPS)

1.0A SCOPE

1.1A Identification

The Software Requirements Specification (SRS) establishes the requirements for the Computer Software Configuration Item (CSCI) identified as the Mesoscale Atmospheric Prediction System (MAPS). MAPS is a supplemental model to the Globally Relocatable Navy Tide/Atmosphere Modeling System (PCTides).

1.2A System Overview

MAPS is a hydrostatic primitive equations model designed to provide high-resolution representations of anemometer level winds and surface pressure as atmospheric boundary conditions for GCOM2D and GCOM3D. To this end, the turbulence closure scheme has been designed to allow the model to be run with its lowest model level at anemometer height, thus providing a direct simulation of the winds at this level. The equations of motion are coded in advective form and solved using a semi-implicit time differencing scheme ensuring that the model is both robust and economical to run, even in regions of steep terrain.

1.3A Document Overview

The SRS summarizes the input and output requirements of MAPS. Each section illustrates the requirements for running the system by a PC Windows interactive menu or by a command prompt. Command prompt operation is exactly the same in the DOS environment as in the UNIX environment. A Software Design Description compliments this document and contains the mathematical formulation, solution procedures, and the Fortran code, as well as flow charts and descriptions of the programs and sub-programs.

2.0A REFERENCED DOCUMENTS

Please refer to 2.0 Referenced Documents.

3.0A REQUIREMENTS

This section discusses the MAPS capabilities, interface, adaptation, and resource requirements. MAPS has been written to be user friendly and platform independent, by which the model can be executed through a graphical user interface or a DOS mode or UNIX command line prompt. All MAPS configuration managed routines and subroutines are written in FORTRAN 90.

3.1A CSCI Capability Requirements

The MAPS portion of the model contributes an atmospheric forcing element to the model. It provides high resolution spatial representation of the wind and pressure fields for GCOM2D/3D.

Within each of its several capabilities are subfunctions that serve to input information into the model and to produce a variety of output files for the specified analysis region which are described in the following subsections. For each subfunction, a description of inputs and outputs are provided for both PC Windows menu and command prompt use. Figure 3.1-1A illustrates the interactions between the functions and subfunctions within the PC Windows interactive menu.

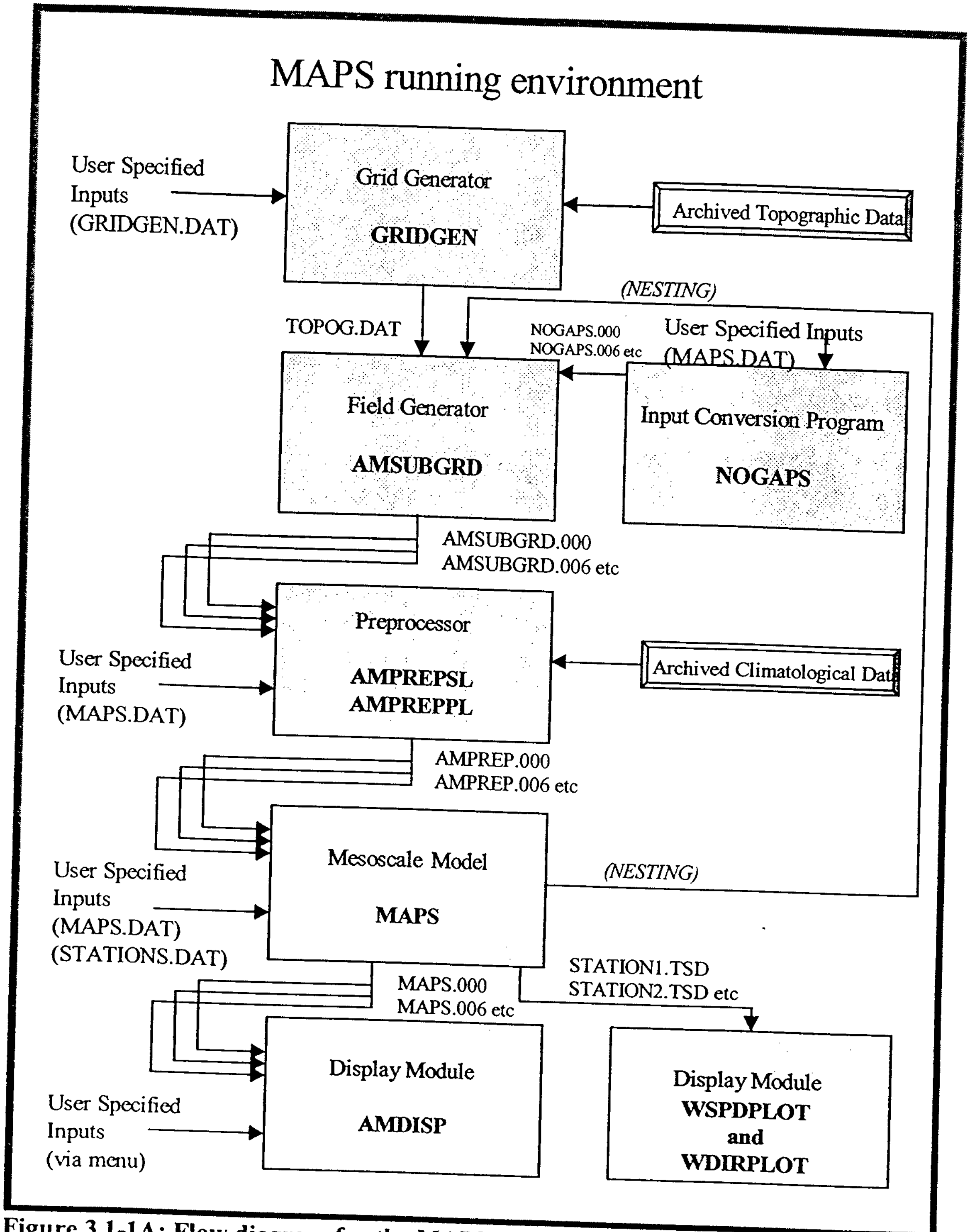

Figure 3.1-1A: Flow diagram for the MAPS system.

3.1.1A Set Up Grid and Topography

3.1.1.1A Define the model domain

The first step is to define the model domain.

Command prompt

Input:
To define the model domain at the command prompt, the file "gridgen.dat" in the "\gems\work" directory is edited. It is structured as follows:

Line	Parameter	Typical value
1	Arbitrary Title	Spain
2	Grid Projection Flag (do not change)	3
3	Southern Latitude Limit	28.0000
4	Northern Latitude Limit	43.0000
5	Western Longitude Limit	343.0000
6	Eastern Longitude Limit	2.0000
7	Standard Grid Spacing (km)	20.0

Note: Longitudes are in the range 0 to 360E. Latitudes are in the range –90 to +90.

Output:
File "gridgen.dat".

Menu

Input:
The "Generate Grid" menu option is selected which initiates the Applied Sciences Associates (ASA) grid selection program. This software allows the user to zoom in and create a new region by selecting the area for the model grid on the map with the mouse.

Output:
On completion the ASA grid generator writes an ASCII file to the "\gems\gridgen\depths" directory with an extension ".asc". This ASCII file contains the latitude and longitude limits of the region selected.

3.1.1.2A Generate topography grid

Command prompt

The next task is to generate the topographic grid.

Input:
Run "gridgen". "Gridgen" reads the latitude and longitude limits from the file "gridgen.dat" and calculates the topography and bathymetry from the global direct access files.

Output:
"Gridgen" writes the data to the file "topog.dat" in the "\gems\work" directory.

Menu

Input:
Select "Get Topography".

Output:
"Mapsgrid" writes the topography and bathymetry to the file "topog.dat" in the "\gems\work" directory.

3.1.2A Set parameters for controlling the type of forcing and model output

Before running the atmospheric model the user must set several parameters which control the type of forcing and model output.

3.1.2.1A Set MAPS parameters

There are a few parameters that must be specified for the model run. These are stored in the file "maps.dat" which has the following structure (sample values at end of line):

Line	Parameter	Typical Value
1	Nesting Model Name (NOGAPS or MAPS)	nogaps
2	NOGAPS Unix File Path	/net/omaha/export/posey/disk2/graeme/
3	Start Time (hh,dd,mm,yyyy)	00 23 06 1999
4	Maximum Run Time (Hours)	24
5	Number Of Sigma Levels	16
6	Sigma Levels	0.100 0.200 0.250 0.300 0.400 0.550 0.700 0.780 0.850 0.900 0.950 0.975 0.990 0.995 0.998 0.999
7	Output File Time Interval (Hours, 0=None)	6
8	Time Step Factor (0 <-> 1)	0.95

MAPS may be nested inside NOGAPS or a previous run of MAPS. When nesting inside a coarse grid MAPS run the model will look for the output file from the previous run, so it is important to make sure the two runs (coarse and fine grids) are consecutive.

Note: Instructions for editing parameter data can be found in the PCTides User's Manual.

Before running MAPS it is necessary to obtain analysis and forcing fields in which the model will be nested. The NOGAPS fields are stored on a UNIX workstation and it is necessary to run the data extraction program on that UNIX box. If MAPS is to be run on a PC there must be a network connection to the UNIX box and the UNIX "root" directory of the "\gems\work" directory must be mounted as drive "h". This section describes the methods for obtaining nesting fields and then preprocessing them into the form required by MAPS.

3.1.2.2A Obtaining Nesting Fields

If the user requires NOGAPS fields it is necessary to use the UNIX system because the NOGAPS output is stored under the UNIX system (path defined in "maps.dat").

Two files must be present in the working directory before extracting the nesting fields:

a. "maps.dat" which sets the nesting model (MAPS or NOGAPS), the path of the NOGAPS files (if required) and the analysis time.
b. "topog.dat" which defines the region required.

Command prompt

In running the system, all other steps regardless of method are exactly the same at the UNIX command prompts as at the DOS mode command prompt. In the case of extracting the nesting fields from NOGAPS however the DOS method is more complex due to the need to communicate between the PC DOS software and the UNIX workstation, via ftp connection or mounted drive connection.

Input:
Run "nogaps".

Output:
The output files are named "nogaps.000", "nogaps.006", "nogaps.012" etc. where the file extension denotes the forecast hour.

Menu

Input:
Select "NOGAPS Fields".

Output:

The output files are named "nogaps.000", "nogaps.006", "nogaps.012" etc. where the file extension denotes the forecast hour.

3.1.2.3A Preprocessing the Nesting Fields

To save disk space the NOGAPS nesting fields are extracted on a domain larger than that defined by "topog.dat" but not on the entire global domain.

<u>Command prompt</u>

Input:

Run "amsubgrd" and then "ampreppl" (for nesting in NOGAPS) or "amprepsl" (for nesting in MAPS).

Output:

Preprocessor writes output files to "amsubgrd.000", "amsubgrd.006", "amsubgrd.012", etc. at each model specified time step.

<u>Menu</u>

Input:

Select "Preprocessor".

Output:

Preprocessor writes output files to "amsubgrd.000", "amsubgrd.006", "amsubgrd.012", etc. at each model specified time step.

3.1.3A Run MAPS

MAPS requires the following files present in the "\gems\work" directory before it is run.

Input:

- **a.** "maps.dat"
- **b.** "stations.dat"
- **c.** "amprep.000" and as many "amprep" files as are necessary to define the model run duration.

<u>Command prompt</u>

Input:

Run "maps".

Output:
Various forms of display options are available for the PC user. The display code has been written for the PC and so there are no display options when running under UNIX. The display options may be run under the PC Windows Menu or at the command prompt.

Menu

Input:
Select "Run MAPS".

Output:
Various forms of display options are available for the PC user. The display code has been written for the PC and so there are no display options when running under UNIX. The display options may be run under the PC Windows Menu or at the command prompt.

3.1.4A Select an output display option

MAPS writes output fields to the direct access binary files "maps.000", "maps.006", "maps.012" etc. at each model output time step (defined by the file extension). Single level (e.g. surface pressure) and multi-level (e.g. winds) fields from the model run may be displayed by running "amdisp" which offers an interactive menu to set display options. The "amdisp" menu appears in both the menu and the PC command prompt environments and each entry parameter is supported with an "F1" help function to explain the option.

Command prompt

Input:
Run "amdisp" and set the options in the menu panel.

Output:
Plots of horizontal surface fields of winds at preselected output time steps.

Menu

Input:
Select "Horizontal fields" and set the options in the menu panel.

Output:
Plots of horizontal surface fields of winds at preselected output time steps.

3.1.4.1A Wind Speed and Direction Time Series

When the user specifies stations in the menu or edits the "stations.dat" file the model produces time series output at those locations and writes to a file with the station name

and an extension of ".tsd". Wind speeds and directions from these file types may then be plotted.

Command prompt

Input:
Run "wspdplot" or "wdirplot" and specify the input station.

Output:
Plot of time series output of selected station.

Menu

Input:
Select "Wind Speed TS" or "Wind Direc TS" and specify the input station.

Output:
Plot of time series output of selected station.

3.1.4.2A Three-dimensional Topography

A three-dimensional surface mesh plot of the model topography (and bathymetry) may be obtained with the program "plot3d". This program reads the "topog.dat" file and offers choices of viewing rotation angle (0-360 from due south) and viewing elevation angle (0-90).

Command prompt

Input:
Run "plot3d".

Output:
Three-dimensional surface mesh plot of topography.

Menu

Input:
Select "3D Topography".

Output:
Three-dimensional surface mesh plot of topography.

3.1.4.3A Two-dimensional Topography

A two-dimensional contour plot of the model topography may be obtained with the program "toplot". This program reads the "topog.dat" file and allows the user to set the minimum plotting contour (meters).

Command prompt

Input:
Run "toplot".

Output:
Two-dimensional topographic contour plots.

Menu

Input:
Select "2D Topography".

Output:
Two-dimensional topographic contour plots.

3.2A CSCI External Interfaces

3.2.1A Interface Identification and Diagrams

The only Navy standard MAPS external interfaces are the input and output files.

3.3A CSCI Internal Interface Requirements

The CSCI will be run from either a PC Windows interactive menu or through a DOS mode or UNIX command prompt. Figure 3.3-1A illustrates the internal interfacing of MAPS.

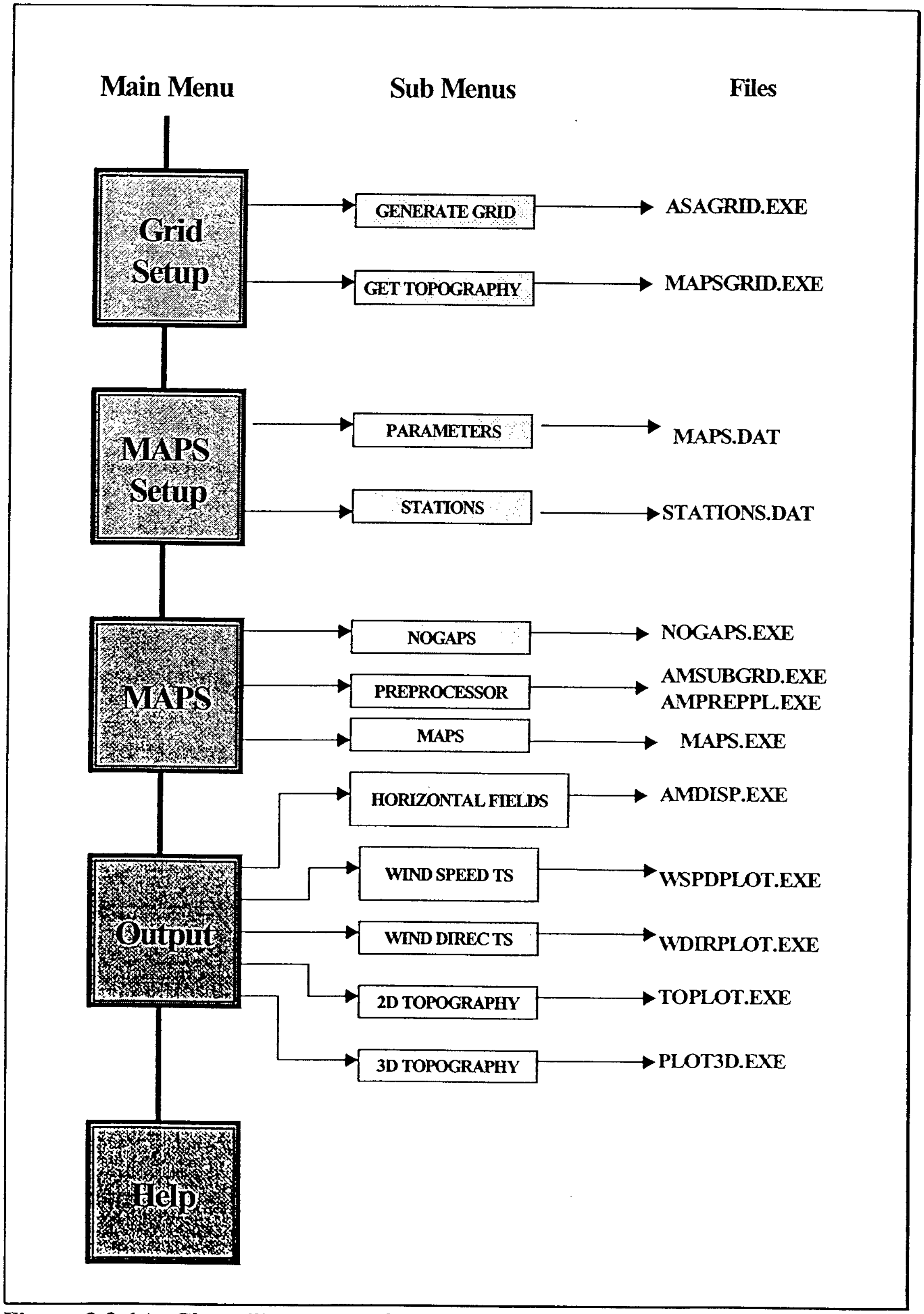

Figure 3.3-1A: Chart illustrating the MAPS PC Windows Menu and related files.

3.4A CSCI Internal Data Requirements

The MAPS running environment contains several other modules and programs that are necessary to complete the modeling system. These include programs for setting up model grids over specified geographic regions, extraction and conversion programs in a suitable format for MAPS and display options for viewing model output (SDD; Hubbert et al., 2000).

MAPS Internal Programs:

1. Grid Generator-GRIDGEN
2. Input Conversion Program-NOGAPS
3. Field Generator-AMSUBGRD
4. Preprocessor-AMPREPSL, AMPREPPL
5. Display Modules-AMDISP, TSPLOT

3.5A Adaptation Requirements

There are no special adaptation requirements.

3.6A Security and Privacy Requirements

There are no CSCI security or privacy requirements.

3.7A CSCI Environment Requirements

The MAPS model can be operated on PC Windows/DOS or UNIX operating systems. The program also could be easily ported to other UNIX-type operating systems such as LINUX by developers familiar with those environments.

3.8A Computer Resource Requirements

Refer to section 3.8.

3.9A Software Quality Factors

MAPS, as part of PCTides, has been proven to perform all required functions and has been thoroughly tested, as evidenced in the Software Test Description. Due to the modularity of the program, problems can be easily corrected, and the program can be adapted to changing requirements or modified for use in a new environment. The CSCI is user-friendly and can be utilized in a variety of applications.

3.10A Design and Implementation Constraints

None.

3.11A Training and Personnel-Related Requirements

Personnel must be trained in the use of either UNIX or the PC Windows operating systems to properly enter data and evaluate the model results to assure high quality output from MAPS. The interactive menu offered in the PC Windows format of this program greatly simplifies manipulation of the CSCI input and output options.

3.12A Other Requirements

None.

3.13A Precedence and Criticality of Requirements

None.

4.0A QUALIFICATIONS PROVISIONS

See Qualifications Provisions section of PCTides Software Requirements Specification.

5.0A REQUIREMENTS TRACEABILITY

See Requirements Traceability section of PCTides Software Requirements Specification.

6.0A NOTES

6.1A Acronyms

ASA	Applied Sciences Associates
CSCI	Computer Software Configuration Item
CSC	Computer Software Component
GCOM2D	Coastal Ocean Model 2-D
GCOM3D	Coastal Ocean Model 3-D
GEMS	Global Environmental Modeling Systems
GMT	Generic Mapping Tool
MAPS	Mesoscale Atmospheric Prediction System
NOGAPS	Navy Operational Global Atmospheric Prediction System
NRL	Naval Research Laboratory
OAML	Oceanographic and Atmospheric Master Library
PC	Personal Computer
PSI	Planning Systems, Incorporated
SDD	Software Design Description
SRS	Software Requirements Specification
SSC	Stennis Space Center
STD	Software Test Description
UNIX	Workstation Operating System